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PERFORMANCE ANALYSIS OF FAST UNSCENTED KALMAN FILTERS FOR ATTITUDE DETERMINATION IN UNSW-EC0 CUBESAT ENGINEERING MODEL

Abstract

The Unscented Kalman Filter is a well-established estimation algorithm for non-linear applications. The estimation accuracy of the UKF is higher than the Extended Kalman Filter (EKF) for satellite attitude determination problem, due to the non-linear nature of the attitude dynamics and observations. However, the UKF requires a significantly higher number of numerical operations than the EKF and cannot be used in CubeSats in which the computational resource is limited. In this paper, an attitude determination performance analysis of two newly developed Fast Unscented Kalman Filters for CubeSat is presented. The engineering model of the UNSW-EC0 CubeSat developed by the Australian Centre for Space Engineering Research (ACSER) is used for the experimentation. The attitude dynamics are expressed using quaternion. A gyro, a magnetometer, earth and a sun sensor are used for observations. The EKF, UKF and the new UKFs called the Single Propagation Unscented Kalman Filter (SPUKF) and the Extrapolated Single Propagation Unscented Kalman Filter (ESPUKF) are implemented separately in the Attitude Determination Computer (ADC) of the engineering model which is based on 32-bit ARM7 processor. The computation time, accuracy and processor power consumption of all the estimation algorithms are compared.